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E.O. 10501 dtd 5 Nov 1953; ONR Navy ltr dtd 1 Apr 1968

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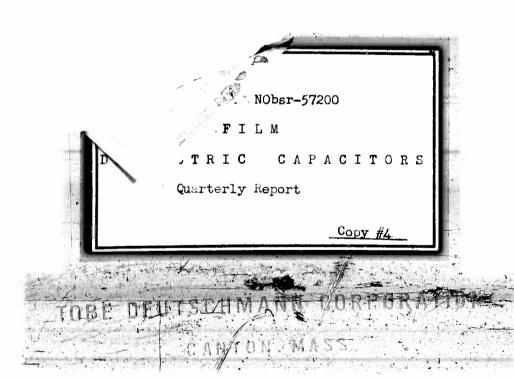
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Quarterly Development Report

for

DEVELOPMENT OF-

FILM DIELECTRIC CAPACITORS --- HIGH TEMPERATURE

- 0 -

This report covers the period Sept. 30, 1953 to Dec. 30th, 1953

TOBE DEUTSCHMANN CORPORATION

Providence Highway Norwood, Massachusetts

NAVY DEPARTMENT BUREAU OF SHIPS ---- ELECTRONICS DIVISION

Contract No. NObsr - 57200

Index No. NE-111016, St. 1

Date of Contract: Feb. 20, 1952

Date of Report: Jan. 9, 1954

FURTHER MILIT

Bulletti.

ONLY TO

CMP Classification: Class "A" Product

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Certification DO-A-7; certified under CMP Regulation No. 3

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I-N F-O-R-M-A T I O N

R-ESTRIC-T-E-D

ABSTRACT

PHASE I.

All testing at 85° C, has been completed. Sufficient information on the characteristics of Mylar at 85° C. has been gathered so that capacitors may be designed for operation up to this temperature.

The testing program is now continuing at 125 °C.

PHASE II.

In the metallized version of a Mylar Capacitor, considerable information has been accumulated on the .25 MFD. Capacitors, constructed of a single .0005" Metallized Mylar film.

Method and equipment to produce the margin required for other film combinations has been developed.

During the next quarter, work will proceed on these other combinations.

S-E-C-U-R-I-T-Y I-N-F-O-R-M-A-T-I-O-N R-E-S-T-R-I-C-T-E-D

Part I.

PURPOSE

A. Develop Film Dielectric Capacitors, high-temperature, utilizing DuPont "Mylar" Film (V-200) or equivalent, as a capacitor dielectric, in order to achieve higher temperature operation and greater reliability of fixed paper capacitors, in accordance with Bureau of Ships Contract Specification --
SHIPS F-400, dated 15 September, 1951, as follows:

B. Phase I.

- Evaluate a V-200 film or equivalent in accordance with paragraph 3.2.1 of referenced Bureau of Ships Contract Specification SHIPS F-498.
- Furnish fifty (50) each of various capacitors as described in paragraph 3.2.1 of referenced Bureau of Ships Contract Specification SHIPS F-498.
- 3. Submit reports as specified therein.

C. Phase II.

- Evaluate a V-200 film or equivalent with metallized electrodes in accordance with paragraph 3, 2, 2, of referenced Bureau of Ships Contract Specification SHIPS F-499.
- Furnish fifty (50) each of various capacitors as described in paragraph 3.2.1 of referenced Bureau of Ships Contract Specification SHIPS F-499.

C. Phase II (continued)

- 3. Furnish one (1) set of Type D, Class IV Manufacturing Drawings in accordance with Bureau of Ships Specification 16D19 (RE), dated 15 January 1946, and Amendment No. 2, dated 1 May 1948.
- 4. Submit reports as specified herein.

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GENERAL FACTUAL DATA

Phase I.

Sufficient information has now been gathered at 85° C, to consider this phase of the project complete, and to establish characteristics of Mylar Capacitors at this temperature.

As much of this information as possible will be used to run parallel tests at 125° C. without the great multitude of tests that were necessary at the first test temperature.

When a large number of Mylar units were placed on Life Test at 125° C. during this last quarter, it was noted that an unforseen amount of current was required from the Life Test power supply.

Upon further investigation, it was found that the Insulation Resistance of Mylar Capacitors showed a considerable variation with applied test voltage at 125° C.

S-E-C-U-R-I-T-Y

I-N-F-O-R-M-A-T-I-O-N

R-E-S-T-R-I-C-T-E-D

GENERAL FACTUAL DATA (continued) PHASE I

This characteristic of Mylar had not been revealed at the 85° test point, and it was necessary to reduce the number of units on test so as not to place a large overload on the Life Test protection circuits.

This characteristic of Mylar will necessitate the plotting of curves, of Insulation Resistance vs. Applied Voltage at elevated temperature; and if the indications already given under Life Test are typical, the character-

Examinations of the Life Test failures reveal that the Mylar undergoes significant physical changes at 125°C. It loses much of its flexibility when observed in combination -- that is, four layers of Mylar and two of Aluminum Foil.

istic of Mylar under these conditions will be rather poor.

When the individual layers are separated, the change is less apparent, but there is a definite crispness to the material that formerly was very soft.

It is not brittle and the entire section can be readily unwound, but it does not fall in a shapely mass.

-0-0-0-0-0-0-0-0-0-

GENERAL FACTUAL DATA

PHASE II.

To date, all information has been gathered on the .25 Mfd. unit construction of a single layer of .5 and .25 Metallized Mylar as a dielectric. This limitation is due to the fact that margining equipment to produce margins of any other width than those normally used on Metallized Paper have not been available.

S-E-C-U-R-I-T-Y

I-N-F-O-P- M-A-T-I-O-N

R-E-S-T-R-I-C-T-E-D

GENERAL FACTUAL DATA (continued) PHASE II

During this last quarter, we have developed a machine and the necessary technique to margin any width required for Mylar.

This will allow us to resume testing on Metallized Mylar at a more reasonable rate.

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DETAIL FACTUAL DATA

PHASE I

According to plan, the work done this past quarter was conducted at the elevated temperature of 125° C. The type unit which was used for investigation was the 1 Mfd. capacitor, constructed with two layers of .0005" Mylar C Film between foils. The gauge of the individual rolls of Mylar used, varied between a low of .00048" and a high of .0006". The high rolls were balanced against the low ones to maintain a maximum total thickness not to exceed .00112".... the margins in all cases being 1/4".

- A. Seventy-five units were divided into three groups of Twenty-five each:
 - Tested at 1000 v.d.c., one unit failed voltage test prior to Life Test. It was a mechanical failure.

The remaining twenty-four units were placed on Life Test, and seventeen completed 83 hours. All seven failures were caused by Mylar break-downs. (See Part III, P. 1.)

S-E-C-U-R-I-T-Y I-N-F-O-R-M-A-T-I-O-N

R-E-S-T-R-1-C-T-F-D

DETAIL FACTUAL DATA -- Phase I (continued)

- 2. Tested at 1200 v.d.c., one unit failed voltage test prior to Life Test. It was a mechanical failure. The remaining twenty-four units were placed on Life Test, and five completed 75 hours.

 All nineteen failures were caused by Mylar break-downs. (See Part III, P. 2.)
- 3. Tested at 1500 v.d.c., three units failed voltage test prior to Life Test. All were mechanical failures. The remaining twenty-two units were placed on Life Test, and all failed within 41 hours.

 There were six mechanical failures and sixteen were caused by Mylar faults. (See Part III, P. 3.)
- B. Seventy-five were divided into three groups of twenty-five each,
 - 1. Tested at 800 v.d.c., three units failed voltage test prior to Life Test. Two were mechanical failures, and one a Mylar fault. The remaining twenty-two units were placed on Life Test, and fifteen completed 72 hours. There were six Mylar failures and one mechanical. (See Part III, P. 4.)
 - 2. Tested at 900 v. d. c., two units failed voltage test prior to Life Test. Both were mechanical failures. The remaining twenty-three units were placed on Life Test, and fourteen completed 73 hours. There were eight Mylar failures, and one mechanical. (See Part III, P. 5.)

DETAIL FACTUAL DATA --- Phase I (continued)

3. Tested at 1000 w.d.c., one unit failed voltage test prior to Life Test. It was a mechanical failure. The remaining twenty-four units were placed on Life Test, and thirteen completed 73 hours. There were eight Mylar failures, and three mechanical. (See Part III, p. 6.)

-0-0-0-0-0-0-0-0-0-0-0-0-

DETAIL FACTUAL DATA PHASE II

Similarly, all tests performed during this last quarter were at 125°C. The unit used for test purposes was the .25 Mfd. capacitor, constructed with a single layer of .0005" Metallized Mylar as the dielectric.

- A. Seventy-five units were divided into three groups of twenty-five each:
 - Tested at 400 v.d.c., three units failed tests prior to Life Test. One failed voltage test and two were "opens." All were mechanical failures.

The remaining twenty two units we e placed on Life Test, and sixteen completed 250 hours. Six units opened during Life Test. (See Part III, PP. 8, 9, 10.)

DETAIL FACTUAL DATA --- Phase II (continued)

2. Tested at 500 v.d.c. all units passed tests

prior to Life Test. All twenty-five units

were placed on Life Test, and fifteen completed

251 hours.

Eight units opened during Life Test, and two units failed during pre-breakdown tests. One was a Mylar failure; the other a mechanical, (See Part III, pp. 11, 12, 13.)

- 3. Tested at 600 v, d c, three units opened prior to

 Life Test. The remaining twenty-two units were
 placed on Life Test, and five completed 251 hours.

 Fifteen units opened during Life Test; one failed
 pre-breakdown test, and one failed completely at
 the start of the Life Test. (See Part III, pp. 14, 15.

 16.)
- B. Seventy-five units were divided into three groups of twenty-five each:
 - 1. Tested at 300 v.d.c., two units opened prior to Life
 Test. The remaining twenty-three units were placed
 on Life Test, and eighteen completed 250 hours.
 Five units opened during Life Test. (See Part III.
 pp. 17, 18.)
 - 2. Tested at 400 v. d.c., four units opened prior to Life Test. The remaining twenty-one units were placed on Life Test, and twelve completed 250 hours. Nine units opened during Life Test. (See Part III, PP. 19, 20.)

DETAIL FACTUAL DATA ---- Phase II (continued)

3. Tested at 500 v. d. c. four units opened prior to

Life Test, and seven completed 254 hours. Thirteen

units opened during Life Test, and one unit failed

completely because of Mylar faults. (See Part III,

pp. 21, 22.)

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CONCLUSIONS

PHASE I.

All the data gathered on Mylar Capacitors at 85° C. up to this date point to the conclusion that Mylar is capable of producing a Capacitor of generally better characteristics than Kraft Paper capacitors over this same temperature range.

However, the characteristics of Mylar are extremely erratic from lot to lot of material and indications are that a considerable amount of work remains to be done in the control of the manufacturing process of Mylar Film.

If these processes could be controlled so that the bulk of the Capacitors produced would have characteristics equal to the best of these lots of Mylar, a capacitor greatly superior to Kraft Paper could be produced.

However, under present conditions, no reasonable prediction could be made of the characteristics of any production lots of Capacitors. Indications have been found that the Insulation Resistance of Mylar capacitors drops very fast at elevated temperature as the voltage is increased.

Not enough data has been collected on this point to draw a conclusion.

CONCLUSIONS

PHASE II

All indications from these tests point to one conclusion.

With the present quality of Mylar, the Metallized version

of the Mylar Capacitor seems to be the one which can produce
a capacitor of consistent characteristics.

The faults and inconsistencies of the material are hidden or wiped out when the capacitor is first cleared of faults.

A considerable amount of work, remains to be done to improve the quality of margining and the methods of making corrections to the Metallized Mylar Capacitor so as to reduce the number of opens in Life Test.

This, however, is not a fault in the basic characteristics of the material, but a manner of improving manufacturing techniques, and no difficulty is anticipated in solving this problem.

S-E-C-U-R-I-T-Y I-N-F-O-R-M-A-T-I-O-N

R-E-S-T-R-I-G-T-E-D

P A R T

PROGRAM FOR NEXT INTERVAL

PROGRAM FOR NEXT INTERVAL

PHASE I

The number of tests conducted at 125° C, with the ! Mid. capacitor constructed with two layers of ,0005" Mylar C between foils are insufficient to form a conclusion.

Thus, approximately 12 groups of 25 each of these units will be made and tested until a definite maximum voltage stress is established for 125° C, test.

The 150° C, series of tests using the same number of samples as used for 85° C. - 125° C, series will begin in approximately six weeks.

PHASE II

The greatest difficulty encountered with Metallized Mylar C to date has been the number of "opens" that occur during Life Test. Our first objective during the next interval is to find the cause of the phenomenon and eliminate it.

This is not a characteristic peculiar to Mylar -- but a reflection on method used for making contact. Development is required on confacting methods before proceeding with further Life Test on this phase.

Then we will repeat the Life Test at varying voltage stresses with an attempt to establish a relationship between the number of temporary or self-healing breakdowns to the applied voltage stress per mil of dielectric.

S-E-C-U-R-I-T-Y

I N-F-O-P- M- A-T- I-O-N

R-E-S-T-R-I-C-T-E-D

PART III

TEST DATA

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ENGINEERING DEPT.			C.1. 1002			•	PORE DE	28		8	CORPORATION	-							DRYDOD,	E E	2		
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Number Open After Life	0	0	\ o	- 10	0	•
Margin	1/4"	1/4"	1/4"	1/4"	1/4.	1/4"
Lot Meteriel	2 & 3	2 8 3	2 & 3	28 Z		6. 18.
% Mylar Failures	29%	86	100%	28.58	368	38%
Mylar Failures	7	19	76	- - -	- ∞a	00
Mechanical	0	0	9	~ - ·	+	m
Started on Life	77	73	8	2	. .	7
Failed Before Life	٦	-	"	Ē		-
Number of Units	25	25	52	. 52	25	70 7
Temp.	125° C.	125° C.	125° C.	125° C.	125° c.	125° C.
Nobar Voltage	1000 VDC	1200 VDC	1500 VDC	800 VDC	SOU VEC	LUUU VDC
Nóber #	123	124	125	126	17.7	128

SPECIFICATION LYBERINGHTOL - MCTAILIZED SPECIFICATION LYBERINGHTOL HOURS ON TEST 250 Date started (1) November 1953 Tray # 1 - 4055 Date finished	74//20	Inrot.	CONTRACT NO.	Nobsr 5	57 200
SPECIFICATION EXACTING 12/2/ FOR WHON V. SOURS ON TEST 250 Clock # 1 - 4055 Date finished November 1953 Tray # 1 December	VEON /	1,		Nobsr	00
MOURS ON TEST 250 Clock # 1 - 405-5 Date finished November 1953 Tray # 1 Date mber		•			
November 1953 Tray + 1 - 4055 Date finished	TEMPERATURE	125 '0	VOLTAGE	400 10C	
100 Ch 100	Date	Clock	1- 4303	Total Hours	150
		BEFORE LI	,		4
	9 10	12 13 14	16 17 16	19 20 21 22	2 23 24 25
- 100 0C P 3 P A P P P P P P P P P P P P P P P P			0		1
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LIFE TEST PAILURES IN HRS.		, o	66,	oper of en	200
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		25		25	
		y '	101	10	99/
Rope 8 Date		ta collected by	HJ. VW.	Τ.	
CLEARERING IMPT. C.L. 1002 TORE DRUTSCHAAFE	DEUTSCHIAM	CORPORATION		MORNOD. N	YLSS
				T	

NObsr M #38

Twenty-five . 25 Mfd.
single . 5 mil
Metallized Mylar C Units

The units (22) were wired to a Life Test rack, and the total capacitance measured at room temperature. Following this, they were heated in an oven to 125° C. for one-half hour. The capacitance was measured at 125° C.

Then the units were exposed to 400 v.d.c. pre-breakdown test for one-half hour. During this period, there were 33 self-healing breakdowns. The capacitance was again measured before the Life Test commenced.

Temporary Breakdowns	Total Capacitance	Elapsed Time
0	6.15 Mfd.	Start of Test
46	5.90 "	22 hours
46	5.80 "	46 "
47	4.80 "	11 8 "
47	5.00 "	140 "
47	5.15 "	164 "
47	5. 65 ''	186 "
47	5. 70 "	210 "
47	5. 60 ''	217 **
47	5.40 "	239 "
47	5.15 "	244 "
47	5.50 "	250 "

Test Completed

NObsr M #38 (continued)

Number of units started on test	
Number finished	
Total capacitance before Life Test at room temperature	5.70 Mfd.
Total capacitance before Life Test at 125° C	6.60 Mfd.
Total capacitance after pre-breakdown test	6.15 Mfd.
Total capacitance after Life Test	5.50 Mfd.
Number of permanent failures 0	
Number of temporary failures	
Number of opens at the end of the test 6	

S-E-C-U-R-I-T-Y I-N-F- C-R-M-A-T-I-O-N R-E-S-T-E-I-C-T-E-D

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64	250						TING	PERATURE	URE	`	25	9			2	VOLTAGE		500		7007		T		
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NUMBER OF TEMPORARY BREAKDOWNS vs. TEMPERATURE

NObsr # 39

Twenty-five .25 Mfd.
Single .5 mil
Metallized Mylar C Units

The units (25) were wired to a Life Test rack, and the total capacitance measured at room temperature. Following this, they were heated in an oven to 125°C, for one-half hour. The capacitance was measured at 125°C. Then the units were exposed to 500 v.d.c. pre-breakdown test for one-half hour.

Unit #14 failed completely after 109 temporary failures, and unit #8 after 118 temporary failures. In all, there were 122 self-healing failures during this period. The capacitance was again measured before the Life Test commenced.

Temporary Breakdowns	Total Capacitance	Elapsed Time
0	5.95 Mfd.	Start of Test
21	5.10 "	22 hours
26	5.70 "	44 "
28	5. 20 "	68 ''
29	5. 40 "	135 "
29	5.50 "	158 "
29	5. 2 5 "	180 "
29	5, 25 "	228 "
29	5, 40 "	251 "
	Test	Completed

Page 12.

NObsr M #39 (continued)

number of units started on test)
Number finished	
Total capacitance before Life Test at room temperature	6.20 Mfd.
Total capacitance before Life Test at 125° C	7.50 Mfd.
Total capacitance after pre-breakdown test	5.95 Mfd.
Total capacitance after Life Test	5.40 Mid.
Number of premanent failures	0
Number of temporary failures	122
Number of opens at the end of the test	8

S-E-C U-R-I-T-Y I-N-F-O-R-M-A-T-I-O-N R-E-S-T-R-I-C-T-E-D

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NUMBER OF TEMPORARY BREAKDOWNS vs. TEMPERATURE

NObsr M #40

Twenty-five .25 Mfd.
single .5 mil
Metallized Mylar C Units

The units [22] were wired to a Life Test rack, and the total capacitance measured at room temperature. Following this, they were heated in an oven to 125° C. for one-half hour. The capacitance was measured at 125° C. The units were then exposed to 600 v. d. c. pre-breakdown test for one-half hour.

Unit #19 failed completely after 124 temporary breakdowns. In all, there were 312 self-healing failures during this period. The capacitance was again measured before the Life Test commenced.

Temporary	Breakdowns	Total Cap	acitance	Elapse	d Time
	0	4. 35	Mfd.	Start o	of Test
	387	3, 95	11		hours d completely
	453	3.60	ii.	19	hours
	830	3.90	11	43	11
	947	2.90	11	115	н
	950	2.55	ti.	138	Ħ
	950	2.80	11	162	1)
	95 0	2,55	11	184	18
	951	2.20	11	251	11

Test completed

NObsr M #40 (continued)

Number of units started on test
Number finished 5
Total capacitance before Life Test at room temperature 5.40 Mfd.
Total capacitance before Life Test at 125° C 6.60 Mfd.
Total capacitance after Life Test
Total capacitance after pre-breakdown test 4.35 Mfd
Number of permanent failures
Number of temporary failures 951
Number of opens at the end of the Life Test

S-E-C-U-R-I-T-Y I-N-F-O-R-M-A-T-I-O-N

R-E-S-T- P-L-C-T-E-D

Page 16.

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NObsr M #41

Twenty-five . 25 Mfd.
single . 5 mil
Metallized Mylar C Units

The units (23) were wired to a Life Test rack and the total capacitance measured at room temperature. Following this, they were heated in an oven to 125° C. for one-half hour. The capacitance was then measured at 125° C.

Next, the units were exposed to 300 v.d.c. pre-breakdown test for one-half hour. During this period, there were no breakdowns. The capacitance was again measured before the Life Test commenced.

Temporary Breakdowns	Total Capacitance	Elapsed Time
0	6.20 Mfd.	Start of Test
0	. 6.20 "	69 hours
0	6.0 "	96 ''
0	5. 90 "	143 "
0	6.0 "	214 "
0	5. 90 "	234 "
0	5.90 "	25 6 "
		M

Test completed

Number of units started on test		
Number finished 18		
Total capacitance before Life Test at room temperature	5.60	Mfd.
Total capacitance before Life Test at 125° C	6.2	Mfd.
Total capacitance after pre-breakdown test	6.2	Mfd.
Total capacitance after Life Test	5.90	Mfd.
Number of permanent failures 0		
Number of temporary failures 0		
Number of opens at the end of the test 5		

					LIFE	TEST	RECORD	2										1		
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NOber M #42

Twenty-five . 25 Mfd.
single . 5 mil
Metallized Mylar C Units

The units (21) were wired to a Life Test rack, and the total capacitance measured at room temperature. Following this, they were heated in an oven to 125° C, for one-half hour. The capacitance was measured at 125° C.

The units were then exposed to 400 v.d.c. pre-breakdown test for one-half hour. During this period, there were no breakdowns. The capacitance was again measured before the Life Test commenced.

Temporary Breakdowns	Total Capacitance	Elapsed Time
0	5.3 Mfd.	Start of Test
6	5.6 "	69 hours
6	5.4 "	96 "
6	5.2 "	143 "
6	4.95 "	214 "
6	4.80 "	234 "
6	4.75 "	257 "
		Test Completed

Number of units started on test 21	
Number finished 12	
Total capacitance before Life Test at room temperature	
Total capacitance before Life Test at 125° C	5.90 Mfd.
Total capacitance after pre-breakdown test	5.3 Mfd.
Total capacitance after Life Test	4.75 Mfd.
Number of permanent failures 0	
Number of temporary failures 6	
Number of opens at the end of the test 9	

S-E-C-U-R-I-T-Y I-N-F-O-R-M-A-T-I-O-N

R-E-S-T-R-L-C-T-E-D

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TOBE DEUTSCHAFF CORPORATION

ENGINEERING DEPT. C.L. 1002

Page 21

NObsr M #43

Twenty-five .25 Mfd. single .5 mil
Metallized Mylar C Units

The units (21) were wired to a Life Test rack, and the total capacitance measured at room temperature. Following this, they were heated in an oven to 125° C. for one-half hour. The capacitance was measured at 125° C.

Next, the units were exposed to 500 v.d.c. pre-breakdown test for one-half hour. During this period, there were 57 self-healing breakdowns. The capacitance was again measured before the Life Test commenced.

Temporary Breakdowns	Total Capacitance	Elapsed Time					
0	6.00 Mfd.	Start of Test					
303	3.42 Mfd.	67 hours					
349	4.0 Mfd.	94 "					
349	3.85 Mfd.	141 "					
349	3.85 Mfd.	212 "					
349	3.80 Mfd.	232 "					
349	3,70 Mfd.	254 "					
		Test Completed					

Number of units started on test	
Number finished 7	
Total capacitance before Life Test at room temperature	
Total capacitance before Life Test at 125° C	5.90 Mfd.
Total capacitance after pre-breakdown test	6.00 Mfd.
Total capacitance after Life Test	3.70 Mfd.
Number of permanent failures 1	
Number of temporary failures 349	
Number of opens at the end of the test 13	

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